CHARGE TO REVIEWERS

Peer Review of:

EPA's INDUSTRIAL WASTE FACILITY EVALUATION MODEL

INTRODUCTION AND BACKGROUND:

The EPA has developed software for the purpose of evaluating non-hazardous, Industrial Solid Waste Management units (WMU) with regard to the ability of the WMU to contain waste for the purpose of protecting the quality of groundwater. The object of this review, EPA's *Industrial Waste Facility Evaluation Model (IWEM)*, was developed as part of EPA's voluntary *Guide for Industrial Waste Management*, to be released for public comment in the spring of 1999.

The purpose of the *Guide* is to provide state regulatory agencies, non-hazardous waste facility operators, and the public information and tools to use in evaluating the design of proposed waste management units. The *Guide* is intended as a means of facilitating information exchange among industry and environmental stakeholders, while at the same time enhancing the quality of analysis that supports decision-making.

The groundwater component of the *Guide* recommends a three-tiered approach to evaluating the protective nature of three different WMU liner designs: no liner (native soil underlying the WMU); single-clay liner; composite liner consisting of a geomembrane material above a clay liner. The first tier is a look-up table of protective levels for disposal of 190 constituents, based upon a ground-water fate-and-transport evaluation using data from around the United States. The second tier involves analysis of seven site-specific parameters using a neural network tool, designed to determine protective levels. The third tier involves a comprehensive risk analysis using appropriate ground-water models and significant site-characterization. The three-tiered approach is intended to give facilities and state regulators the ability to screen and do simplified analyses for which few data are required, while leaving the option for a detailed, more data-intensive analysis.

The *Guide* provides *IWEM* for the purpose of supporting the Tier 1 and Tier 2 analyses. The software consists of two programs: the "national" and "location-adjusted" evaluations, to support the Tier 1 and Tier 2 analyses, respectively. The "national evaluation" program consists of a look-up table of maximum leachate concentrations of chemical constituents that, after dilution and attenuation during transport through the ground-water pathway, would not exceed health-based concentrations (risk level of 10^{-6}) at a monitoring well 150 m from the WMU. These maximum concentrations, or leachate concentration threshold values (LCTVs) were derived by modeling with the EPA's

Composite Model with Transformation Products (EPACMTP), a ground-water fate and transport model.

The second program, the "Tier 2" or "location-adjusted evaluation" consists of four artificial neural networks (ANNs) that have been to trained to simulate the results of EPACMTP. The seven most sensitive parameters were used as the basis for the development of the ANNs. The seven hydrogeologic and WMU-specific parameters may be entered to the software as constants, and the ANN solves for the appropriate LCTV that would reflect dilution and attenuation by the hydrogeologic system.

EPACMTP is a fate-and-transport model developed by the Office of Solid Waste to evaluate contaminant migration from land disposal units (landfills, surface impoundments, waste piles, and land application units). EPACMTP simulates one-dimensional, vertically downward transport through the unsaturated zone and two-dimensional, or three-dimensional flow and transport in the saturated zone. The model accounts for the following processes affecting contaminant fate and transport: advection, hydrodynamic dispersion, linear or nonlinear equilibrium sorption, chained first-order decay reactions, and dilution from recharge in the saturated zone. The hydrologic properties of the aquifer are considered to be isotropic and homogeneous.

EPACMTP was developed for regulatory purposes and is based upon several assumptions which can result in over-estimation of constituent concentration expected values at the monitoring well. EPACMTP has been used by the Office of Solid Waste in a variety of rule-makings and risk assessments; e.g., the Toxic Characteristic Rule (ref) and the Petroleum Listing (need correct name and ref.) The database that supports EPACMTP is based upon data collected from around the United States. Thus, the values generated when EPACMTP is run in Monte Carlo mode are considered to be appropriate on a national level. Previous reviews by the EPA's Science Advisory Board (SAB) have supported the use of EPACMTP for national-level risk evaluations, but have cautioned against its use for site-specific purposes.

Determination of the LCTV is accomplished by comparing the desired concentration at the monitoring well (e.g., Maximum Concentration Limit, MCL; or Health-Based Number, HBN) with an arbitrary disposed concentration to determine the requisite amount of dilution and attenuation between the source and the monitoring well (DAF). The DAFs determined with EPACMTP in a Monte Carlo analysis are sorted from high to low and the 90^{th} percentile lowest value is used to estimate the maximum leachate concentration (LCTV) in the WMU:

$$DAF^* MCL = LCTV$$

The Tier 1, national evaluation results were determined directly by this method. The tier 2, location-adjusted evaluation neural network was developed by using the results of the EPACMTP runs, along with specific values for seven input parameters.

MATERIALS OFFERED FOR REVIEW:

To be reviewed according to the charge:

EPA'S *Industrial Waste Facility Evaluation Model (IWEM)*
Technical Background Document for IWEM
User's Guide for IWEM

Supporting Documentation:

Overview and Theory of EPACMTP
Evolution of EPACMTP
A Composite Modeling Approach for Subsurface Transport of Degrading Contaminants from Land-disposal Sites

CHARGE TO THE REVIEW PANEL:

The overall objective of the tiered approach to non-hazardous waste facility evaluation is to allow for differences in information and modeling needs from one facility to another. Specifically, one facility may wish to dispose of material with very low concentrations of a particular constituent while at the same time having very little information concerning the hydrology of the proposed site. Another facility may have a suite of chemicals that represent a range of leachate concentrations; and have much hydrologic characterization data for the site. The tiered modeling approach is also intended to facilitate modeling by those who have little training in ground-water modeling, but understand the basic principles of hydrology. As a modeling tool, IWEM is intended to address these differences in data and modeling capabilities among facilities. The *Guidance* and IWEM are intended to facilitate discussion among state regulators, industry, and community environmental groups.

In reviewing the IWEM software and accompanying documentation, the review panel is requested to focus on four major areas:

1) The application of EPACMTP to the Tier 1 and Tier 2 analyses;

2) The assumptions and parameters used to develop the Tier 1 and Tier 2 evaluations;

3) The quality and appropriateness of the neural network tool for its intended purpose;

4) The overall quality of the software and documentation.

Specifically:

The Application of EPACMTP to the Tier 1 and Tier 2 Evaluations

Reviews of EPACMTP by the SAB and other independent peer-review panels have focused on the assumptions, approaches to sampling, and the computational methods. This review is not intended to be a review of EPACMTP, *per se*, but instead a review of its application to the development of IWEM.

– Comment on the tiered approach to analysis of the WMU liner-design. Does it serve the intended purpose?

– Given the assumptions for the Tier 1 evaluation, is EPACMTP an appropriate tool to use? Are the results appropriate for the type of analysis?

– Is EPACMTP an appropriate tool for generating the response surfaces modeled by the artificial neural networks? Is there another tool or modeling approach that would serve the purpose of the Tier 2, location-adjusted evaluation?

The Assumptions and Parameters Used to Develop the Tier 1 and Tier 2 Evaluations

– Comment on the assumptions and parameter ranges used for developing the Tier 1 National Evaluation. Are the assumptions appropriate for the type of analysis? Are the parameter ranges reasonable?

– Comment on the approach to estimating infiltration for the various WMUs and liner designs. Is the use of regional climatic data sufficient to generate appropriate ranges for the no-liner and single clay liner scenarios? Are the assumptions used for developing the infiltration rates for the no-liner, single clay liner and composite liner appropriate and realistic? If not, please recommend other assumptions or approaches to estimating infiltration. Is there a way to modify the approach to determining liner- dependent infiltration rates in a way that balances long-term liner failure with the efficacy of long-term liner maintenance?

– Comment on the parameters used for the Tier 2 Location-adjusted Evaluation. Are the parameters appropriate to the type of analysis? Are they parameters that would generally

be known about a site? Should more parameters be included? If so, which ones? Should parameters be deleted?

The Quality and Appropriateness of the Artificial Neural Network Tool

In training the ANNs, parameter values that ranged between the 10^{th} and 90^{th} percentile of the parameters distribution were used. Consequently, the ANNs were not trained in the range of infiltration rate assumed for the composite liner (3×10^{-5} m/yr). The resultant error between EPACMTP and the ANNs when using the composite liner infiltration rate was considered unacceptable. Thus, the composite liner scenario is not included in the Tier 2 evaluation for this draft of IWEM.

– Comment on the overall approach to developing the neural networks. Was the program used for training the ANNs appropriate?

– Comment on the number of parameters, the range of values, and the combinations used for training. Is there a training method or approach that would enable inclusion of parameter values span many orders of magnitude?

– Comment on the overall quality of the ANNs as described by the various criteria used. Are there other criteria that should be used to evaluate the quality of the ANNs? Is the error between EPACMTP and the ANNs acceptable in the context of the uncertainties associated with groundwater modeling?

– Comment on the various approaches used to filling in the response surface for the purpose of getting a better fit between EPACMTP and the ANNs. Is there a method for better incorporating the extremes of the parameter distributions?

– Comment on the approaches to selecting the training, test, and validation data sets.

The Overall Quality of the Software and Documentation

– Comment on the ease-of-use and logic of IWEM.

– Comment on the nature of the instructions within the program. Are they clear and easy to understand?

– Comment on the layout of the user-interface screens. Are all easy to use and read?

– Comment on the presentation of results. Are they consistent and easy to understand?

– Comment on the ease of installation and file manipulation (saving and retrieval?)

– Comment on the logic and clarity of the documentation. Were any important points, assumptions missing or inadequately explained?

– Comment on the structure of the user's guide. Is it easy to follow? Are there any inconsistencies with the software?

– Comment on the readability of the user's guide. Can is be used by one without a lot of groundwater modeling experience?

– Comment on the structure of the Technical Background Document. Is the modeling approach and logic used for development of the ANNs clear?

– Is there sufficient explanation concerning the training of the ANNs? What aspects of the training should be described? What training parameters and training data need to be presented?

– Comment on the readability of the Technical Background Document. Is it written at a level appropriate for someone with some groundwater training and modeling experience?